

## CLAIMS

1        1. A plasma display panel (hereafter referred to as 'PDP')  
2 driving method for a PDP in which a plurality of discharge cells  
3 are arranged between a pair of substrates, the PDP driving method  
4 repeating the following steps to perform image display:

5        a set-up step for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;

8        a write step for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image; and

11       a discharge sustain step for applying at least one sustain  
12 pulse to each discharge cell after the write step to perform a  
13 sustain discharge in the selected discharge cells,

14       wherein the set-up pulse applied during the set-up step has  
15 a staircase waveform that rises in at least two steps.

1       2. The PDP driving method of Claim 1, wherein:

2       the staircase waveform for the set-up pulse is a staircase  
3 waveform that falls in at least two steps.

1       3. The PDP driving method of any one of Claims 1 and 2,  
2 wherein an average rate of change of voltage from the end of a  
3 first-step rise to the end of a second-step rise in the waveform

1 for the set-up pulse is no less than  $1V/\mu s$  but no greater than  
2  $9V/\mu s$ .

1 4. The PDP driving method of any one of Claims 1 to 3,  
2 wherein a voltage jump for the first-step rise in the waveform  
3 for the set-up pulse is no less than  $V_f - 70V$  but no greater than  
4  $V_f$ , when  $V_f$  is a discharge starting voltage.

1 5. A PDP driving method for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5 a set-up step for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;

8 a write step for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image; and

11 a discharge sustain step for applying at least one sustain  
12 pulse to each discharge cell after the write step to perform a  
13 sustain discharge in the selected discharge cells,

14 wherein the set-up pulse applied during the set-up step has  
15 a staircase waveform that falls in at least two steps.

1 6. The PDP driving method of any one of Claim 1 and  
2 Claim 5, wherein the staircase waveform for the set-up pulse is  
3 generated by adding at least two pulses and applying the

4 resulting pulse.

1        7. A PDP driving method, for a PDP in which a plurality of  
2 discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and

8        a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells;

11       wherein the write pulse applied in the write step has a  
12 staircase waveform that falls in at least two steps.

1       8. The PDP driving method of Claim 7, wherein the  
2 staircase waveform of the write pulse applied in the write step  
3 rises in at least two steps.

1       9. The PDP driving method of any one of Claim 7 and Claim  
2 8, wherein a voltage jump for a second-step rise in the waveform  
3 for the write pulse is no less than 10V but no greater than  
4 100V.

1       10. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the

3 PDP driving method repeating the following steps to perform image  
4 display:

5 a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and

8 a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells;

11 wherein the write pulse applied in the write step has a  
12 staircase waveform that rises in at least two steps.

1 11. The PDP driving method of any one of Claim 7 and Claim  
2 10,

3 wherein the staircase waveform of the write pulse in the  
4 write step is generated by adding at least two pulses and  
5 applying the resulting pulse.

1 12. A PDP driving method for a PDP in which a plurality of  
2 discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5 a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and

8 a discharge sustain step for applying at least one sustain

9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the discharge cells;

11 wherein the sustain pulses applied in the sustain step have  
12 a staircase waveform that rises in at least two steps.

1 13. The PDP driving method of Claim 12, wherein:  
2 the staircase waveform for the sustain pulses falls in at  
3 least two steps.

1 14. The PDP driving method of Claim 12, wherein, a voltage  
2 for a first-step rise in the waveform for the sustain pulses is  
3 no less than  $V_f - 20V$  but no greater than  $V_f + 30V$ , when  $V_f$  is a  
4 discharge starting voltage.

1 15. The PDP driving method of any one of Claims 12 to 14,  
2 wherein a time from the end of the first-step rise to the start  
3 of a second-step rise in the waveform for the sustain pulses is  
4 no less than  $T_{df} - 0.2\mu s$  but no more than  $T_{df} + 0.2\mu s$ , when  $T_{df}$  is  
5 a discharge delay time due to the sustain pulses.

1 16. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5 a write step for applying a write pulse to selected

6 discharge cells of the plurality of discharge cells to write an  
7 image; and

8 a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells;

11 wherein the sustain pulses applied in the sustain step have  
12 a staircase waveform that falls in at least two steps.

1 17. The PDP driving method of any one of Claim 12 and  
2 Claim 16, wherein a maximum voltage for the sustain pulses is no  
3 less than  $V_f$ , but no greater than  $V_f + 150V$ , when  $V_f$  is a discharge  
4 starting voltage.

1 18. The PDP driving method of Claim 12, wherein a second-  
2 step rise of the waveform for the sustain pulses corresponds to  
3 a continuous function.

4 19. The PDP driving method of Claim 18, wherein a second-  
5 step rise of the waveform for the sustain pulses is performed  
6 between an end of a charge period in which the discharge cells  
7 are charged to geometrical capacity, and an end of a discharge  
8 current.

1 20. The PDP driving method of Claim 18, wherein the  
2 second-step rise of the waveform for the sustain pulses is  
3 performed between the end of a charge period in which the  
4 discharge cells are charged to capacity, and an end of a

5 discharge current.

1        21. The PDP driving method of Claim 18, wherein in the  
2 waveform for the sustain pulses:

3        a first-step rise corresponds to a trigonometric function  
4 and is completed between a time at which a discharge current  
5 starts to flow and a time at which the discharge current reaches  
6 a maximum value; and

7        a second-step rise is started between a time at which the  
8 discharge current reaches a maximum value and an end of the  
9 discharge current.

1        22. The PDP driving method of any one of Claims 18 to 21,  
2 wherein a first-step fall in the waveform for the sustain pulses  
3 descends to around of a minimum discharge sustain voltage, a rate  
4 of descent corresponding to a trigonometric function.

1        23. The PDP driving method of Claim 18, wherein a second-  
2 step rise in the waveform for the sustain pulses is corresponds  
3 to an exponential function.

1        24. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an

7 image; and

8       a discharge sustain step for applying at least one sustain  
9 pulse to each of the plurality of discharge cells after the write  
10 step to perform a sustain discharge in the discharge cells  
11 corresponding to the written image;

12       wherein the waveform for the sustain pulses applied in the  
13 sustain step is set such that a voltage applied when a discharge  
14 current is highest is higher than a voltage at the discharge  
15 starting point.

1       25. The PDP driving method of Claim 24, wherein:

2       the rise portion of the waveform for the sustain pulses is  
3 in the form of a linear or approximately linear slope that has  
4 a constant gradient.

1       26. The PDP driving method of any one of Claims 12, 16 and  
2 24, wherein the waveform for each sustain pulse is such that a  
3 phase for a variation in the discharge current is set earlier  
4 that a phase for variation in a voltage applied to the discharge  
5 cells during a period in the pulse between a point where a  
6 discharge current starts and a point where the discharge current  
7 reaches a peak value.

1       27. The PDP driving method of any one of Claims 12, 16 and  
2 24, wherein the waveform for the sustain pulses in the sustain  
3 step is generated by adding at least two pulses and applying the  
4 resulting pulse.



1        28. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and

8        a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells;

11       wherein a first sustain pulse applied in the sustain step  
12 has a staircase waveform in which at least one of the rising and  
13 falling portions is performed in at least two steps.

1       29. The PDP driving method of Claim 28, wherein the first  
2 sustain pulse applies a maximum voltage for at least  $0.1\mu s$   
3 longer than for each of second and subsequent sustain pulses.

1       30. The PDP driving method of any one of Claims 28 and 29,  
2 wherein the first sustain pulse applies the maximum voltage for  
3 at least is  $0.02\mu s$  but for no longer than 90% of a pulse width  
4 *PW*.

1       31. The PDP driving method of any one of Claims 12, 16 and  
2 24, wherein in the sustain step, the waveform for the sustain  
3 pulses is generated by adding at least two pulses and applying

4 the resulting pulse.

1        32. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image;

8        a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells; and

11       an erase step for applying an erase pulse to each discharge  
12 cell after the discharge sustain step to erase the image,

13       wherein the erase pulse applied in the erase step has a  
14 staircase waveform that rises in at least two steps.

1       33. The PDP driving method of Claim 32, wherein a voltage  
2 in a first-step rise in the waveform for the erase pulse is no  
3 less than  $V_f - 50V$  but no greater than  $V_f + 30V$ , when  $V_f$  is a  
4 discharge starting voltage.

1       34. The PDP driving method of any one of Claim 32 and  
2 Claim 33, wherein a voltage in a first-step rise in the waveform  
3 for the erase pulse is no less than  $V_f$  but no greater than  $V_f +$   
4 100V, when  $V_f$  is a discharge starting voltage.

1        35. A PDP driving method, for a PDP in which a plurality  
2 of discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a write step for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image;

8        a discharge sustain step for applying at least one sustain  
9 pulse to each discharge cell after the write step to perform a  
10 sustain discharge in the selected discharge cells; and

11       an erase step for applying an erase pulse to each discharge  
12 cell after the discharge sustain step to erase the image,

13       wherein the waveform for the erase pulse applied in the  
14 erase step is a staircase waveform that rises in at least two  
15 steps; and

16       a time between a rise of the erase pulse and a point at  
17 which a maximum voltage ceases to be applied is no less than  $T_{df}$  -  
18  $0.1\mu s$  but no greater than  $T_{df} + 0.1\mu s$ , when  $T_{df}$  is a discharge  
19 delay time for the pulse.

1       36. The PDP driving method of Claim 35, wherein a first-  
2 step rise of the waveform for the erase pulse no less than  $V_f$  but  
3 no greater than  $V_f + 100V$ , when  $V_f$  is a discharge starting  
4 voltage.

1       37. The PDP driving method of any one of Claim 32 and  
2 Claim 35, wherein the waveform for the erase pulse in the erase

3 step is generated by adding at least two pulses and applying the  
4 resulting pulse.

1        38. A PDP driving method for a PDP in which a plurality of  
2 discharge cells are arranged between a pair of substrates, the  
3 PDP driving method repeating the following steps to perform image  
4 display:

5        a set-up step for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;

8        a write step for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image;

11       a discharge sustain step for applying at least one sustain  
12 pulse to each discharge cell after the write step to perform a  
13 sustain discharge in the selected discharge cells, and

14       an erase step for applying an erase pulse to each discharge  
15 cell after the discharge sustain step to erase the image,

16       wherein the waveforms for the set-up pulse applied in the  
17 set-up step, the write pulse applied in the write step, the first  
18 sustain pulse applied in the sustain step and the erase pulse  
19 applied in the erase step is a staircase waveform in which at  
20 least one of the rising and falling portions is performed in at  
21 least two steps.

1       39. A PDP driving method for a PDP in which a plurality of  
2 discharge cells are arranged between a pair of substrates, the

3 PDP driving method repeating the following steps to perform image  
4 display:  
5 a set-up step for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;  
8 a write step for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image;  
11 a discharge sustain step for applying at least one sustain  
12 pulse to each discharge cell after the write step to perform a  
13 sustain discharge in the selected discharge cells , and  
14 an erase step for applying an erase pulse to each discharge  
15 cell after the discharge sustain step to erase an image,  
16 wherein the waveforms for the set-up pulse applied in the  
17 set-up step, the write pulse applied in the write step, the  
18 sustain pulses applied in the sustain step and the erase pulse  
19 applied in the erase step is a staircase waveform in which at  
20 least one of the rising and falling portions is performed in at  
21 least two steps.

1 40. The PDP driving method of any one of Claims 1, 5, 6,  
2 8, 11, 12, 16, 24, 28, 32, 35, wherein a discharge gas is  
3 enclosed in each of the discharge cells in the PDP at a pressure  
4 of 800 to 4 000 torr.

1 41. The PDP driving method of Claim 40, wherein an inert  
2 gas mixture including helium, neon, xenon and argon is used as

3 the discharge gas.

1        42. The PDP driving method of any one of Claim 40 and  
2 Claim 41, wherein the discharge gas is a mixture containing not  
3 more than 5% xenon, not more than 0.5% argon and less than 55%  
4 helium.

1        43. A PDP display apparatus, comprising:  
2        a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4        a driving apparatus including:  
5        a set-up unit for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;  
8        a write unit for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image; and  
11        a discharge sustain unit for applying at least one sustain  
12 pulse to each of the plurality of discharge cells to perform a  
13 sustain discharge in the discharge cells corresponding to the  
14 written image,  
15        wherein the set-up unit includes a pulse adding means for  
16 generating the set-up pulse by adding at least two pulses.

1        44. A PDP display apparatus, comprising:  
2        a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and

4       a driving apparatus including:  
5       a write unit for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and  
8       a discharge sustain unit for applying at least one sustain  
9 pulse to each of the plurality of discharge cells to perform a  
10 sustain discharge in the discharge cells corresponding to the  
11 written image,  
12       wherein the write unit includes a pulse adding means for  
13 generating the write pulse by adding at least two pulses.

1       45. A PDP display apparatus, comprising:  
2       a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4       a driving apparatus including:  
5       a write unit for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and  
8       a discharge sustain unit for applying at least one sustain  
9 pulse to each of the plurality of discharge cells to perform a  
10 sustain discharge in the discharge cells corresponding to the  
11 written image,  
12       wherein the discharge sustain unit includes a adding means  
13 for generating the each sustain pulse by adding at least two  
14 pulses.

1       46. A PDP display apparatus, comprising:

2 a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4 a driving apparatus including:  
5 a write unit for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image;  
8 a discharge sustain unit for applying at least one sustain  
9 pulse to each of the plurality of discharge cells to perform a  
10 sustain discharge in the discharge cells corresponding to the  
11 written image; and  
12 an erase unit for applying an erase pulse to each of the  
13 plurality of discharge cells to erase an image,  
14 wherein the erase unit includes a pulse adding means for  
15 generating the erase pulse by adding at least two pulses.

1 47. A PDP display apparatus, comprising:  
2 a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4 a driving apparatus including:  
5 a write unit for applying a write pulse to selected  
6 discharge cells of the plurality of discharge cells to write an  
7 image; and  
8 a discharge sustain unit for applying at least one sustain  
9 pulse to each of the plurality of discharge cells to perform a  
10 sustain discharge in the discharge cells corresponding to the  
11 written image,  
12 wherein the waveform for the write pulse applied by the



13 write unit and the sustain pulses applied by the discharge  
14 sustain unit have staircase waveforms in which at least one of  
15 the rising and falling portions has at least two steps.

1       48. A PDP display apparatus, comprising:  
2       a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4       a driving apparatus including:  
5       a set-up unit for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;  
8       a write unit for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image;  
11       a discharge sustain unit for applying at least one sustain  
12 pulse to each of the plurality of discharge cells to perform a  
13 sustain discharge in the discharge cells corresponding to the  
14 written image; and  
15       an erase unit for applying an erase pulse to each of the  
16 plurality of discharge cells to erase an image,  
17       wherein the set-up pulse applied by the set-up unit, the  
18 write pulse applied by the write unit, the first sustain pulse  
19 applied by the discharge sustain unit and the erase pulse applied  
20 by the erase unit have staircase waveforms in which at least one  
21 of the rising and falling portions is performed in at least two  
22 steps.

1           49. A PDP display apparatus, comprising:  
2           a PDP in which a plurality of discharge cells are arranged  
3 between a pair of substrates; and  
4           a driving apparatus including:  
5           a set-up unit for applying a set-up pulse to each of the  
6 plurality of discharge cells to accumulate a charge in each  
7 discharge cell;  
8           a write unit for applying a write pulse to selected  
9 discharge cells of the plurality of discharge cells to write an  
10 image;  
11          a discharge sustain unit for applying at least one sustain  
12 pulse to each of the plurality of discharge cells to perform a  
13 sustain discharge in the discharge cells corresponding to the  
14 written image; and  
15          an erase unit for applying an erase pulse to each of the  
16 plurality of discharge cells to erase an image,  
17          wherein the set-up pulse applied by the set-up unit, the  
18 write pulse applied by the write unit, and the sustain pulses  
19 applied by the discharge sustain unit and the erase pulse applied  
20 by the erase unit have staircase waveforms in which at least one  
21 of the rising and falling portions is performed in at least two  
22 steps.

1           50. The PDP display apparatus of any one of Claims 48 and  
2 49, wherein the discharge gas is enclosed in each of the  
3 discharge cells in the PDP at a pressure of 800 to 4 000 torr.